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ULTRAVIOLET ABSORPTION IN THE SPECTRA OF JUPITER

V. F. Kartashov

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ULTRAVIOLET ABSORPTION IN THE SPECTRA OF JUPITER

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ABSTRACT. The results of ultraviolet spectral observations of Jupiter in August 1965 are discussed. The spectrophotometric gradient of Jupiter was determined. The ultraviolet absorption in the spectra of Jupiter is shown to vary and the causes of these variations are discussed.

As a result of observations [1-4] the possibility of variability in /47* ultraviolet absorption in continuous spectra of Jupiter was explained. However this phenomenon was not systematically observed. The aim of the present article is to verify changes in the magnitude of the ultraviolet absorption of Jupiter on the basis of systematic observations conducted in August, 1965.

The spectra of Jupiter were obtained at the Astrophysical Institute of the Academy of Sciences of the Kazakh SSR by means of a slit spectrograph, which furnished a dispersion of 143 Å/mm and which was installed on the AZT-7 mirror-lens telescope (diameter of the input aperture -- 200 mm).

A total of 13 series of spectrograms were obtained, in which the visible region was specially over exposed in order to clarify the far-ultraviolet. The star β Tau/B 81; $1.^{m}78$ was used as a comparison star, since near Jupiter there were no bright stars of a suitable spectral class. The slit of the spectrograph was aligned in the plane of the planetary equator, and its width was 0.05 mm. Observational data are presented in the Table where Z is the zenith distance and ΔM is the difference in atmospheric masses corresponding to the zenith distances of the objects photographed.

Calibration of the spectrograms was accomplished by means of a step attenuator. All of the spectrograms obtained were measured on the MF-2 spectrophotometer. In the band of wavelengths from 3,700 to 4,300 Å

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* Numbers in the margin indicate pagination in the foreign text.

8-10 characteristic curves were plotted, each of which corresponded to a spectific portion of the spectrum; in this connection inclination of the curves was almost identical everywhere.

Then the differences in the monochromatic intensities of Jupiter and β Tau were calculated, in accordance with which the relative spectrophotometric gradient G_u was determined.

As a result of the fact that gradients determined by other authors were obtained by means of comparing Jupiter either with the moon or with a star of the same spectral class, G_u which we obtained must be recalculated with respect to the sun. For this purpose we employed the following formula:

$$E^{24}_{\odot}(\lambda) = \frac{E^{24}_{\beta}\,Tau(\lambda) \cdot E_{\beta}\,Tau(\lambda)}{E_{\odot}(\lambda)},$$

in which the letter E with an appropriate subscript designates the relative distribution intensity over the spectrum of the object. /48

TABLE

Date, 1965	Object	Time of Observations, UT	Z	ΔM
31—1 August	Jupiter	22^h35^m—22^h57^m	53°—54°	0,035—0,1
	β Tau	22 25	50,5	
5—6 »	Jupiter	22 47—23 09	47 —50	0,03
	β Tau	22 27	49,6	
6—7 »	Jupiter	22 48—23 00	45 —48	0,02 —0,05
	β Tau	22 35	46,5	
7—8 »	Jupiter	22 55—23 06	45 —47	0,03 —0,13
	β Tau	22 47	44,2	
8—9 »	Jupiter	22 56—23 06	43,8	0,04
	β Tau	22 45	42,2	
12—13 »	Jupiter	22 54—23 01	43 —45	0,02 —0,03
	β Tau	22 40	41,8	
13—14 »	Jupiter	22 50—23 18	41 —45	0,04 —0,09
	β Tau	22 40	42	
14—15 »	Jupiter	22 55—23 16	40 —42	0,04
	β Tau	22 49	39,8	
15—16 »	Jupiter	23 16	38	0,05
	β Tau	22 50	40,3	
16—17 »	Jupiter	23 28—23 28	38	0,02 —0,05
	β Tau	23 00	36	
18—19 »	Jupiter	23 19—23 30	36 —38	0,025—0,06
	β Tau	23 07	34	
20—21 »	Jupiter	23 11—23 18	36 —38	0,03 —0,06
	β Tau	22 55	34	
21—22 »	Jupiter	23 20—23 38	33 —36	0,05 —0,07
		23 05	31,7	

Tr Note: Commas indicate decimal points.

Energy distribution data according to the spectrum of the sun was taken from the work of I. N. Glushneva [5], while energy distribution according to the β Tau spectrum was taken from the work of A. V. Kharitonov [6]. /49

In comparing all the gradients obtained we see that during the time of the observations noticeable variations in the gradient of Jupiter occur in the ultraviolet (see Figure 1).

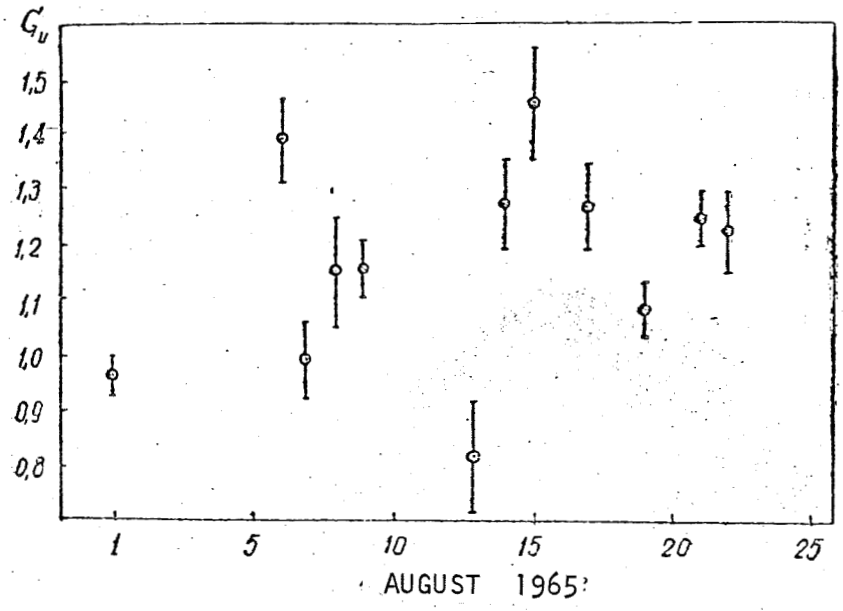

Figure 1. Change in the Spectrophotometric Gradient of Jupiter With Respect to the Sun During August, 1965.

It is possible to make certain assumptions concerning the possible reasons for the change in the relative gradient.

The difference in the zenith distances of the objects photographed might be significant. As can be seen from the Table, the maximum difference ΔZ was for 8-9 August. A difference in atmospheric masses of 0.13 corresponded to such a ΔZ value. Based on the fact that the ratio of monochromatic intensities of objects photographed at various zenith distances equals

$$\frac{I_{1\lambda} \cdot p_\lambda^{M(z_1)}}{I_{2\lambda} \cdot p_\lambda^{M(z_2)}} = \frac{I_{1\lambda}}{I_{2\lambda}} \cdot p^{\Delta M},$$

we find that error which is introduced into the distribution of intensity along the spectrum will depend on the value $p^{\Delta M}$. Assuming that $\Delta M = 0.13$,

we find that this difference in air masses introduces into the intensity distribution an error of less than 5%. The situation obtained is thereby not significantly changed as a result of the difference in zenith distances of Jupiter and the comparison star.

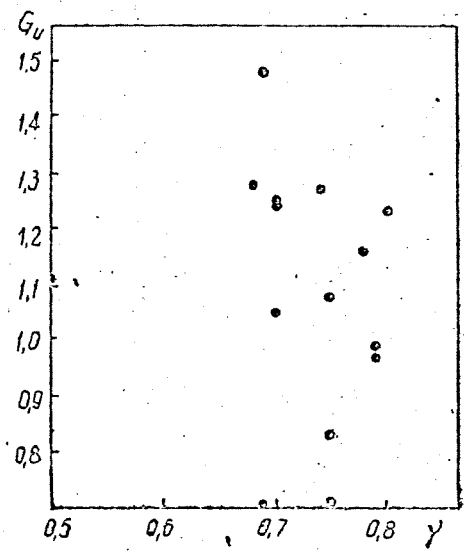

Figure 2. The Relationship Between Relative Spectrophotometric Gradients of Jupiter and the Degree of Contrast of Negatives.

Systematic errors may occur in connection with the processing of photographs, caused by inaccuracies in plotting the characteristic curves for different negatives. However, as shown in Figure 2, there is practically no correlation between the degree of contrast of negatives and the gradient G_u. Finally, the influence of atmospheric dispersion may be reflected in the results.

As a result of differences in the refractive indexes in difference wavelengths, the image of the star is extended along the vertical in the spectrum, the angular length of which in the interval wavelengths from λ_1 to λ_2 will equal

$$\Delta R = \frac{n\lambda_1 - n\lambda_2}{\text{arc } 1''} \tan z,$$

therefore the width of the spectrograph slit must agree with the dimension of the atmospheric spectrum at given zenith distance z, and with given focal length F of the instrument the following equality must obtain

$$b = F \cdot \tan \Delta R = \frac{F \cdot \Delta R}{206265}.$$

With a telescope focus of 2 m, we find that the width of the slit must be not less than 0.018 mm. As indicated above, in all of solar observations the width of the slit was established as 0.050 mm, so that during photography /50

the star was driven along the slit 10-15 times. This means that this effect is eliminated.

Apparently the change in the relative spectrophotometric gradient with time is real.

What are the physical reasons for this phenomenon? At the present time there is no physical theory in which the results obtained find a complete explanation. It is thought that the change in ultraviolet absorption may occur as a result of selectively absorbant chemical compounds or due to a change in the color of the various cloud formations of Jupiter. As a result of a temperature change a change in the coloration of free frozen radicals is possible, which may be present in the cloud formations [7]. As a result of a change in temperature an increase in optical depth may take place and a change in color may occur as a consequence.

A relationship between ultraviolet absorption and solar activity has not yet been established, but as Wegner points out [8], there is a correlation between short-term changes in solar activity and variations in the color of the formations of Jupiter.

It is more probable that the change in the ultraviolet absorption occurs due to intensive activity of the planet itself, in particular due to the release of absorbant matter in the cloud formations.

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